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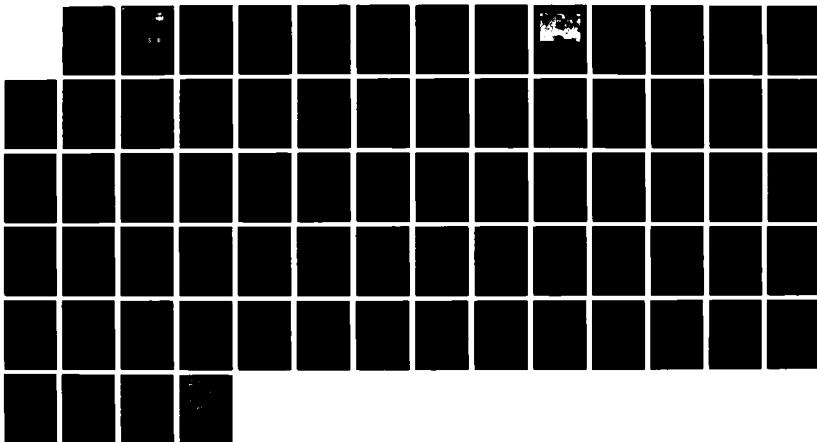
VOLATILE ORGANIC COMPOUND (VOC) TESTING AT BUILDING 348 1/1
KELLY AFB TEXAS(U) AIR FORCE OCCUPATIONAL AND
ENVIRONMENTAL HEALTH LAB BROOKS AF.. G T FAGIN NOV 87

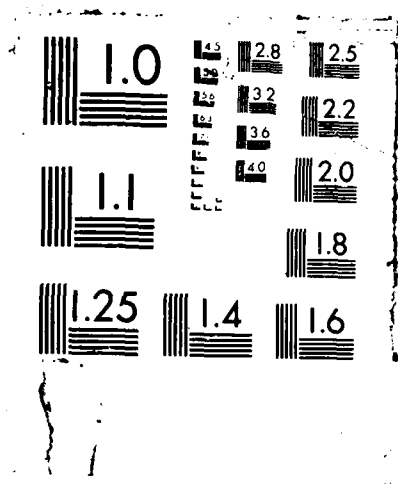
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AD-A189 308

USAFOEHL REPORT
87-147EQ0094LEF



**Volatile Organic Compound (VOC) Testing
at Building 348, Kelly AFB TX**

GUY T. FAGIN, Capt, USAF, BSC

November 1987

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Final Report

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**USAF Occupational and Environmental Health Laboratory
Human Systems Division (AFSC)
Brooks Air Force Base, Texas 78235-5501**

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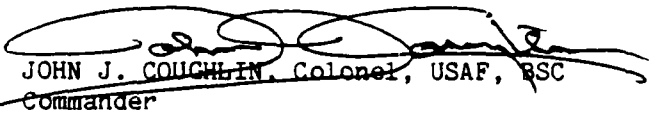
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JOHN J. COUGHLIN, Colonel, USAF, BSC
Commander


Prepared By:

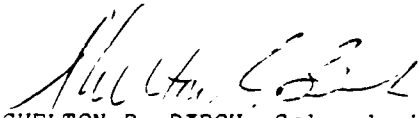

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<p>At the request of HQ AFLC/SGB, the USAFOEHL conducted a stack sampling survey to determine total volatile organic compounds (VOC) being emitted from the Aircraft Engine Fuel Accessories Repair Test Shop No. 1, Bldg 348, Kelly AFB TX. This sampling would include all emissions from unified fuel control stands not vented to the carbon absorber (see USAFOEHL Report 86-094EQ0094KEF). Two of ten representative stacks were sampled and these data were applied to the other eight stacks. A worst case scenario was provided by base personnel. The total VOC emissions for the worst case scenario is 133.15 lb/hr.</p>					
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CONTENTS

	Page
DD Form 1473	i
Illustrations	iv
I. INTRODUCTION	1
II. DISCUSSION	1
III. CONCLUSION	6
References	7
Appendix	
A Personnel Information	11
B NIOSH Sampling Method for Stoddard Solvent	15
C Sampling Equipment	27
D Sample Results and Calculations	31
E Equations	49
F Example Calculations	53
G Field and Analytical Data	57
Glossary	65
Distribution List	66

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NIOSH Approved	<input checked="" type="checkbox"/>
NIOSH 745	<input type="checkbox"/>
Manufactured	<input type="checkbox"/>
Supplier	
By _____	
Date _____	
Availability _____	
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ILLUSTRATIONS

Figure	Title	Page
1	Bldg 348 Ground Floor Plan- Location of Process	2
2	Typical Test Stand with Fuel Control Unit Under Evaluation	3
3	Process Flow Diagram - Test Stand Models 50005 and 50173	4
4	Legend for Schematic of Test Stand Exhaust Systems in Bldg 348	8
5	Schematic of Test Stand Exhaust Systems in Bldg 348, Area D	9
6	Schematic of Test Stand Exhaust Systems in Bldg 348, Area B	10

Table

1	Test Results	42
2	Total Emissions	47
3	Worst Case Scenario	48

I. INTRODUCTION

On 19 and 22 December 86, Volatile Organic Compound (VOC) testing was accomplished on the jet engine fuel control exhaust system at the Kelly AFB Aircraft Engine Fuel Accessories Repair/Test Shop No. 1, Bldg 348. Testing was conducted by the Air Quality Function of the USAF Occupational and Environmental Health Laboratory (USAFOEHL/ECQ). The survey was requested by HQ AFLC/SGB to estimate VOC emissions through each of ten exhaust fans located on the roof of Bldg 348. Those individuals involved with the on-site testing are listed in Appendix A.

II. DISCUSSION

A. Background

The Aircraft Engine Fuel Accessories Repair/Test Shop No. 1 was constructed under Texas Air Control Board (TACB) Permit C-6493. Special Provision No. 1 of Permit C-6493 requires testing to verify values of total VOC emissions.

B. Site Description

Maintenance conducted in Bldg 348 involves the inspection and repair of unified fuel control units and fuel nozzles tested under a "conditional" maintenance concept. The control units are tested prior to disassembly - if a unit passes it is sent back to the field, if it fails it is sent for adjustment and repair. During maintenance, control assemblies are tested on functional stands located in one of two functional test areas. Figure 1 provides a floor plan of Bldg 348 and test stand locations.

The functional test areas contain a combined total of fifty-seven (57) functional test stands. The test stands are large computer controlled modules which simulate actual operation of the fuel control assemblies. A typical fuel control test stand is shown in Figure 2. The test stands are divided into various types, each designed to test specific control units. All test stands do not operate at the same time, due to the varying work load and the considerable amount of time needed to engage and disengage the fuel control assemblies.

At the functional test stand, the flow control or nozzle unit is tested with a calibrating fluid (Stoddard Solvent Military Specification MIL-C-7024C) which is very similar to aircraft fuel. During testing, the fuel control assembly is mounted in a sink equipped with a down draft ventilation system. The sink catches spilled calibrating fluid generated during testing and returns it to a reservoir and exhausts any vapors generated during testing. Fuel nozzles are mounted in a closed test vessel in order to contain fuel mist generated during testing. The test vessel is equipped with a ventilation system to exhaust vapors and a drain to return liquid calibration fluid to a reservoir.

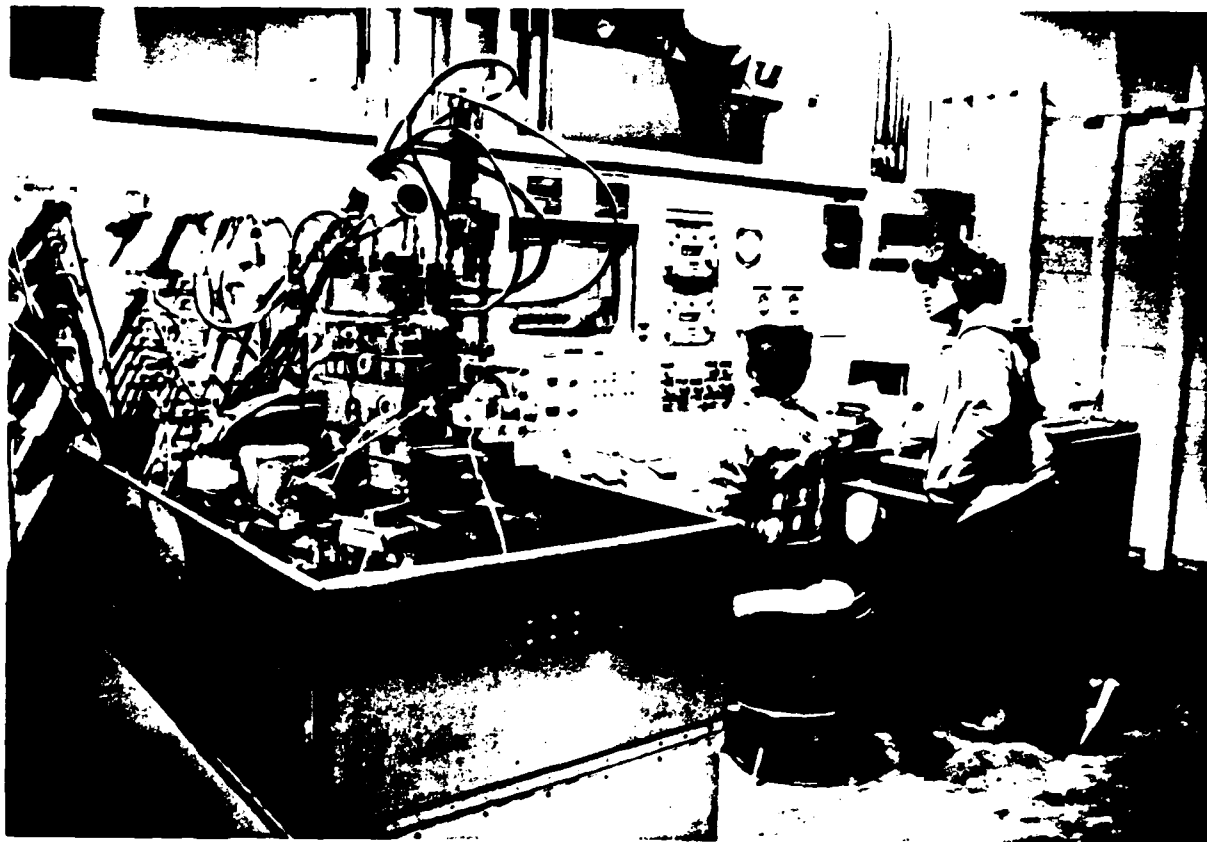


Figure 2: Typical Fuel Control Test Stand

Calibrating fluid is stored in two underground 20,000 gallon storage tanks (supply and return-waste tanks) which are vented to the sink exhaust air. Calibrating fluid is pumped through a fuel control assembly set up in one of two configurations for the unified fuel control stands: (1) closed loop and (2) open body. In the closed loop arrangement, calibrating fluid is pumped through the flow control units in a closed system. After the test is completed, the flow control unit is disconnected from the test stand and any residual calibrating fluid (usually less than one pint) is dumped into the sink to drain to the reservoir. In the open body arrangement, fluid is continuously pumped through the control unit and directly into the sink to return to the reservoir. In the first case, fluid vaporization is minimal compared to the second case where vaporization takes place during the entire test period. The fuel nozzle stands operate by spraying the Stoddard Solvent through nozzles. Fluid is continuously pumped through the nozzle and directly into the sink to return to the reservoir. The major components of the test stand as well as a flow diagram are shown in Figure 3.

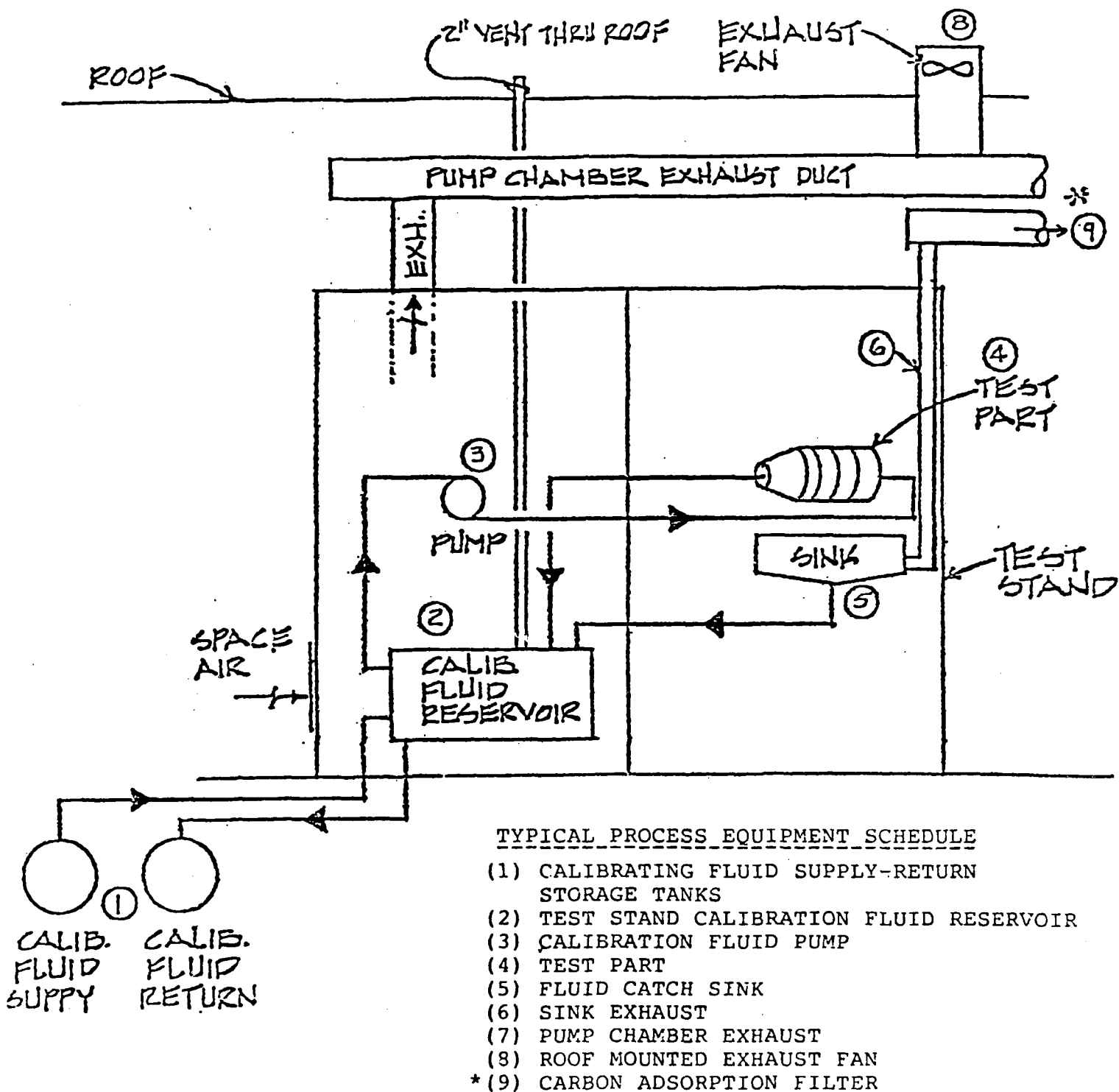


FIGURE 3: PROCESS FLOW DIAGRAM

C. Applicable Standards

The control of VOCs is covered under TACB Regulation V (Texas Administrative Code, Title 31, Chapter 115), Control of Air Pollution from Volatile Organic Compounds and TACB Regulation VI (Texas Administrative Code, Title 31, Chapter 116) Control of Air Pollution by Permits for New Construction or Modification. Specific guidelines are contained in Special Provision No. 1 of TACB Permit C-6493.

D. Sampling Methods and Procedures

The state of Texas has no recommended method for VOCs; therefore, the method is determined by the testing agency with final approval by the state. A presurvey of the operation at Bldg 348 revealed the following facts: (1) Stoddard Solvent is the only VOC exhausted from these stacks; (2) No interfering components (moisture or carbon monoxide) were present to any significant extent in the exhaust gas stream since the gas stream originates in the building with a constantly conditioned environment.

Based on these determinations, Environmental Protection Agency (EPA) Method 18 (40 CFR 60, Appendix A) was selected as the test method. Method 18 provides a set of general guidelines rather than specifications. It is a gas chromatographic analysis method which is applied to appropriate sample collection techniques. Under this method, samples may be collected on sorbents such as charcoal, Tenax or silica gel. In this case, the Adsorption Tube Procedure (Method 18) was selected with the charcoal tube as the collection technique.

Sampling and analysis procedures used during this project conformed to the National Institute of Occupational Safety and Health (NIOSH) method for Stoddard Solvent as suggested in EPA method 18. This method is at Appendix B. Charcoal tubes used were similar to the ones specified by NIOSH except the amounts of adsorbent per primary and back up sections were 800 and 200 milligrams (mg), respectively, as recommended by EPA.

Sampling pumps used were the Dupont Constant Flow Sampler, Model Alpha 2, which is an automatic flow control system capable of maintaining the flow rate within $\pm 5\%$ over pressure drop changes up to 25 inches of water. Pumps were calibrated with a representative charcoal tube in line before and after each run using a bubble tube flowmeter. The bubble tube flowmeter was a "Buck Calibrator" by Gilian Instruments Corp incorporating a fixed volume flow tube, quartz controlled timer and microprocessor. The unit is a primary standard with an accuracy of $\pm 0.50\%$. A more detailed description of the equipment used in this project is at Appendix C.

The grouping of the test stands along with the exhaust system for each group in the two functional areas (areas B & D) are presented in Figures 4-6. The particular test stands of interest for this study were those vented to the

outside environment with no applied air pollution controls. VOCs vented to the carbon adsorption unit are reported in USAFOEHL Report 86-0943EQ0094KEF Evaluation of Organic Vapor Activated Carbon Adsorption System, Kelly AFB TX dated October 1986.

The unified fuel control test stands have a cabinet and a sink exhaust. Nearly all of the VOCs will be vented through the sink exhaust since this is the area where the calibration fluid flows openly. The cabinet exhaust vents the enclosed area behind the test stands. This area has small leaks and drips which occur at the connections of the calibration fluid pumping system. The actual percentage of total VOCs exhausted through the sink as opposed to the cabinet exhaust vents is unknown; however, it was assumed that all VOCs were generated from the sink exhaust system.

Each group of stands is vented to a common exhaust duct identified by a numbered exhaust fan. The final exhaust duct for each group was a vertical round duct with diameters ranging from about 24-37 inches. Each duct terminates on the roof with an exhaust fan; no exhaust stack extends above the fan. A means of determining duct velocities above the roof was not available; therefore, each system had to be sampled inside the building approximately 15-20 feet above the floor. Due to the very limited accessibility to the ventilation system, two exhaust ducts (EF 13 & EF 27) were chosen to be evaluated and act as representatives for the remaining systems.

The velocities in each duct were determined using the methods outlined in EPA Method 2. Three sampling pumps were positioned at the location of the velocity determination with each pump drawing a sample through a single charcoal tube.









III. CONCLUSION

This stack sampling was accomplished to estimate VOC throughput and determine emission parameters for a Texas Air Control Board operating permit for the facility.

Appendix D presents all operating parameters and calculations. The laboratory results can be seen in Table 1. Table 2 provides the total output of all exhaust fans if all fuel nozzle and unified fuel control stands would be used simultaneously. Kelly AFB personnel provided us with a "worst case scenario," Table 3; this scenario identifies the maximum number of test stands operating at any one time. The emission of VOCs from each individual exhaust fan is calculated in appendix D. The total VOC emissions for the worst case scenario is 133.15 lb/hr.

REFERENCES

1. Code of Federal Regulations (CFR), Vol 40, Part 68, The Office of the Federal Register National Archives and Records Service, General Services Administration, Washington DC, July 1, 1984.
2. Texas Air Control Board, Regulation V (Texas Administration Code, Title 31, Chapter 115), Control of Air Pollution from Volatile Organic Compounds.
3. Texas Air Control Board, Regulation VI (Texas Administration Code, Title 31, Chapter 116), Control of Air Pollution by Permits for New Construction or Modification.
4. Sampling Procedures Manual, Texas Air Control Board, January 1983 (revised July 1985)
5. NIOSH Manual of Analytical Methods, Vol 3, U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, Centers for Disease Control, Cincinnati, Ohio, April 1977, pp 382-1 to 382-9

<u>LEGEND</u>			TYPES OF TEST STANDS (BY #)	SYMBOL
INDEX	AREA "D"	AREA "B"		
1	13	15	50002	
2	9	—	50173	
3	4	—	50175	
4	2	—	50010-3	
5	2	—	50010-1	
6	2	—	TF39	
7	2	—	T56	
8	—	6	50004	

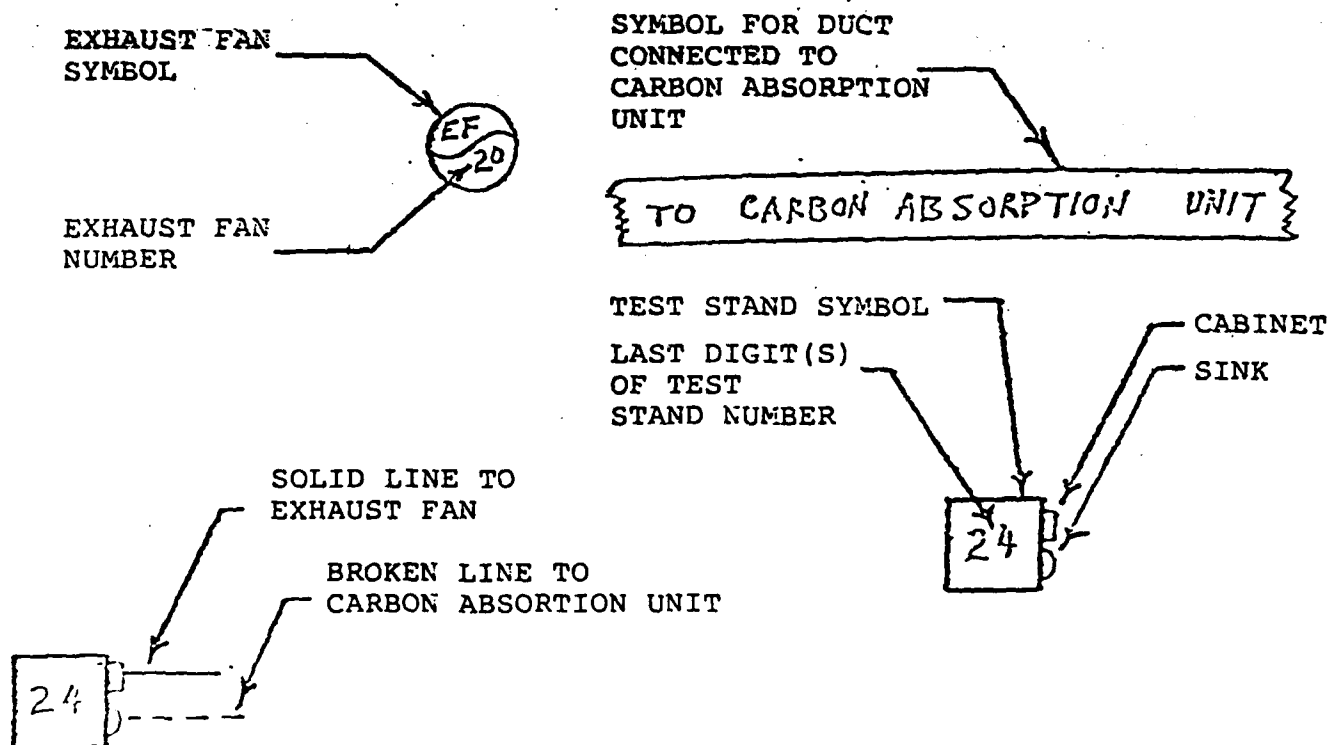


FIGURE 4 SCHEMATIC OF TEST STAND EXHAUST SYSTEMS IN BLDG 348

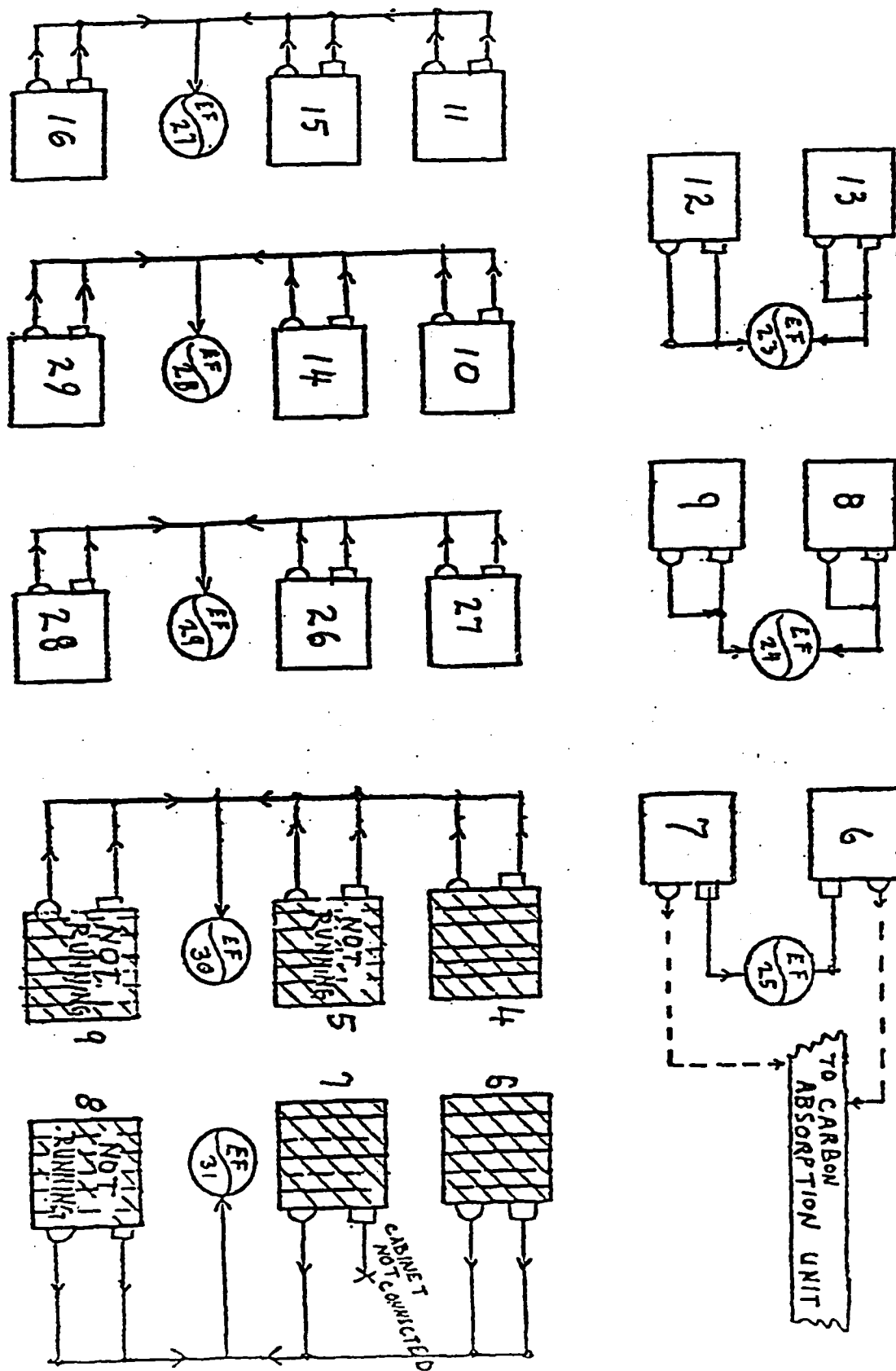
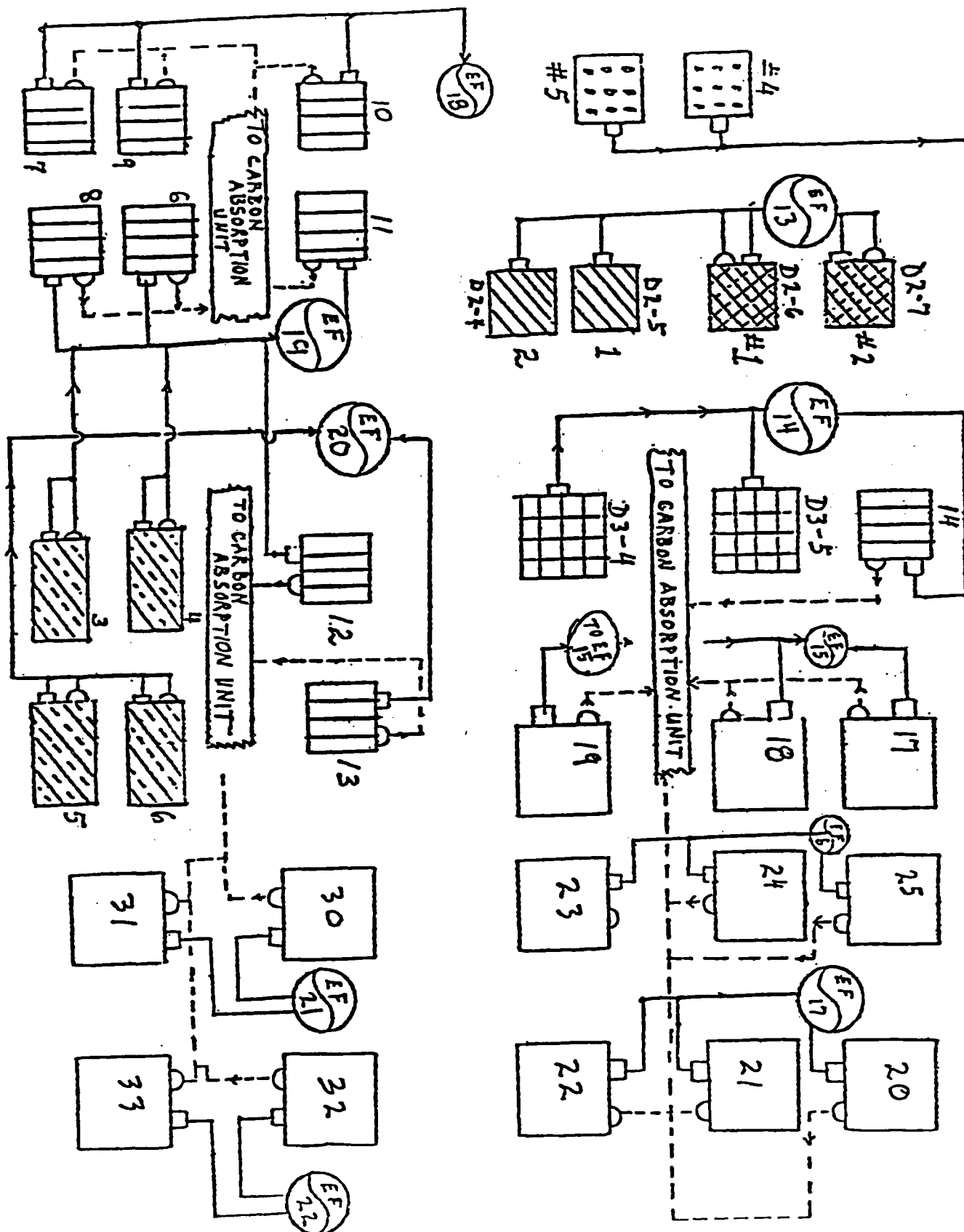


FIGURE 5 AREA "B" SCHEMATIC OF TEST STAND

EXHAUST SYSTEM IN BLDG 348



AREA "D"

SCHEMATIC OF TEST STAND

EXHAUST SYSTEM IN BLDG 348

FIGURE 6

APPENDIX A
Personnel Information

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1. Test Team:

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APPENDIX B

NIOSH Sampling Method for Stoddard Solvent

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Stoddard Solvent

Analyte:	Stoddard Solvent	Method No.:	S382
Matrix:	Air	Range:	1417-5940 mg/m ³
OSHA Standard:	500 ppm (2950 mg/m ³)	Precision (CV _T):	0.052
Procedure:	Adsorption on charcoal, desorption with carbon disulfide, GC	Validation Date:	3/14/75

1. Principle of the Method

- 1.1 A known volume of air is drawn through a charcoal tube to trap the organic vapors present.
- 1.2 The charcoal in the tube is transferred to a small, stoppered sample container and the analyte is desorbed with carbon disulfide.
- 1.3 An aliquot of the desorbed sample is injected into a gas chromatograph.
- 1.4 The total area of the resulting peaks is determined and compared with corresponding areas obtained from injection of standards.

2. Range and Sensitivity

- 2.1 This method was validated over the range of 1417-5940 mg/m³ at an atmospheric temperature and pressure of 24°C and 749 mm Hg, using a 3-liter sample. Under the conditions of sample size (3 liters) the probable useful range of this method is 295-8850 mg/m³ at a detector sensitivity that gives nearly full deflection on the strip chart recorder for a 26.6 mg sample. This method is capable of measuring much smaller amounts if the desorption efficiency is adequate. Desorption efficiency must be determined over the range used.
- 2.2 The upper limit of the range of the method is dependent on the adsorptive capacity of the charcoal tube. This capacity varies with the concentrations of analyte and other substances in the air. The first section of the charcoal tube was found to hold 26.3 mg of analyte when a test atmosphere containing 6026 mg/m³ of analyte in air was sampled at 0.19 liters per minute for 23 minutes; breakthrough was observed at this time, i.e., the concentration of analyte in the effluent was 5% of that in the influent. (The charcoal tube consists of two sections of activated charcoal separated by a section of urethane foam (See Section 6.2). If a particular atmosphere is suspected of containing a large amount of contaminant, a smaller sampling volume should be taken.

3. Interference

- 3.1 When the amount of water in the air is so great that condensation actually occurs in the tube, organic vapors will not be trapped efficiently. Preliminary experiments using toluene indicate that high humidity severely decreases the breakthrough volume.
- 3.2 When two or more compounds are known or suspected to be present in the air, such information, including their suspected identities, should be transmitted with the sample.
- 3.3 When analyzing solvent mixtures such as this analyte, search for differences in gas chromatographic patterns between field samples and bulk or head space samples as evidence of an interference. It must be emphasized that any compound which has the same retention time as the analyte at the operating conditions described in this method is an interference. Retention time data on a single column cannot be considered as proof of chemical identity.
- 3.4 If the possibility of interference exists, separation conditions (column packing, temperature, etc.) must be changed to circumvent the problem.

4. Precision and Accuracy

- 4.1 The Coefficient of Variation (CV_t) for the total analytical and sampling method in the range of 1417-5940 mg/m^3 was 0.052. This value corresponds to a 153.4 mg/m^3 standard deviation at the OSHA standard level. Statistical information and details of the validation and experimental test procedures can be found in Reference 11.2.
- 4.2 On the average the values obtained using the overall sampling and analytical method were 4.7% lower than the "true" value at the OSHA standard level.

These data are based on validation experiments using the internal standard method.

5. Advantages and Disadvantages of the Method

- 5.1 The sampling device is small, portable, and involves no liquids. Interferences are minimal, and most of those which do occur can be eliminated by altering chromatographic conditions. The tubes are analyzed by means of a quick, instrumental method. The method can also be used for the simultaneous analysis of two or more substances suspected to be present in the same sample by simply changing gas chromatographic conditions from isothermal to a temperature-programmed mode of operation.

5.2 One disadvantage of the method is that the amount of sample which can be taken is limited by the number of milligrams that the tube will hold before overloading. When the sample value obtained for the backup section of the charcoal tube exceeds 25% of that found on the front section, the possibility of sample loss exists.

5.3 Furthermore, the precision of the method is limited by the reproducibility of the pressure drop across the tubes. This drop will affect the flow rate and cause the volume to be imprecise, because the pump is usually calibrated for one tube only.

6. Apparatus

6.1 A calibrated personal sampling pump whose flow can be determined within $\pm 5\%$ at the recommended flow rate. (Reference 11.3)

6.2 Charcoal tubes: glass tube with both ends flame sealed, 7 cm long with a 6 mm O.D. and a 4 mm I.D., containing 2 sections of 20/40 mesh activated charcoal separated by a 2 mm portion of urethane foam. The activated charcoal is prepared from coconut shells and is fired at 600°C prior to packing. The absorbing section contains 100 mg of charcoal, the backup section 50 mg. A 3 mm portion of urethane foam is placed between the outlet end of the tube and the backup section. A plug of silylated glass wool is placed in front of the absorbing section. The pressure drop across the tube must be less than 1 inch of mercury at a flow rate of 1 liter per minute.

6.3 Gas chromatograph equipped with a flame ionization detector.

6.4 Column (6 ft x 1/8 in stainless steel) packed with 1.5% OV-101 on 100/120 mesh Chromosorb W.

6.5 An electronic integrator or some other suitable method for measuring peak areas.

6.6 Two milliliter sample containers with glass stoppers or Teflon-lined caps. If an automatic sample injector is used, the associated vials may be used.

6.7 Microliter syringes: 10 microliter, and other convenient sizes for making standards.

6.8 Pipette: 1.0 mL type graduated in 0.1 mL increments.

6.9 Volumetric flasks: 10 mL or convenient sizes for making standard solutions.

7. Reagents

7.1 Chromatographic quality carbon disulfide

7.2 Stoddard Solvent (Boiling range: 159-176 °C)

7.3 Undecane, or other suitable internal standard

7.4 Purified helium

7.5 Prepurified hydrogen

7.6 Filtered compressed air

8. Procedure

8.1 Cleaning of equipment. All glassware used for the laboratory analysis should be detergent washed and thoroughly rinsed with tap water and distilled water.

8.2 Calibration of Personal Pumps. Each personal pump must be calibrated with a representative charcoal tube in the line. This will minimize errors associated with uncertainties in the sample volume collected.

8.3 Collection and Shipping of Samples

8.3.1 Immediately before sampling, break the ends of the tube to provide an opening at least one-half the internal diameter of the tube (2 mm).

8.3.2 The smaller section of charcoal is used as a back-up and should be positioned nearest the sampling pump.

8.3.3 The charcoal tube should be placed in a vertical direction during sampling to minimize channeling through the charcoal.

8.3.4 Air being sampled should not be passed through any hose or tubing before entering the charcoal tube.

8.3.5 A maximum sample size of 3 liters is recommended. Sample at a rate of 0.2 liter per minute or less. The flow rate should be known with an accuracy of at least $\pm 5\%$.

8.3.6 The temperature and pressure of the atmosphere being sampled should be recorded. If pressure reading is not available, record the elevation.

8.3.7 The charcoal tubes should be capped with the supplied plastic caps immediately after sampling. Under no circumstances should rubber caps be used.

8.3.8 One tube should be handled in the same manner as the sample tube (break, seal, and transport), except that no air is sampled through this tube. This tube should be labeled as a blank.

8.3.9 Capped charcoal tubes should be packed tightly and padded before they are shipped to minimize tube breakage during shipping.

8.3.10 A sample of the bulk material should be submitted to the laboratory in a glass container with a Teflon-lined cap. This sample should not be transported in the same container as the charcoal tubes.

8.4 Analysis of Samples

8.4.1 Preparation of Samples. In preparation for analysis, each charcoal tube is scored with a file in front of the first section of charcoal and broken open. The glass wool is removed and discarded. The charcoal in the first (larger) section is transferred to a 2 mL stoppered sample container. The separating section of foam is removed and discarded; the second section is transferred to another stoppered container. These two sections are analyzed separately.

8.4.2 Desorption of Samples. Prior to analysis, 1.0 mL of carbon disulfide is pipetted into each sample container. (All work with carbon disulfide should be performed in a hood because of its high toxicity.) Desorption should be done for 30 minutes. Tests indicate that this is adequate if the sample is agitated occasionally during this period. If an automatic sample injector is used, the sample vials should be capped as soon as the solvent is added to minimize volatilization. For the internal standard method, desorb using 1.0 mL of carbon disulfide containing a known amount of the chosen internal standard.

8.4.3 GC Conditions. The typical operating conditions for the gas chromatograph are:

1. 30 mL/min (60 psig) Helium carrier gas flow
2. 35 mL/min (25 psig) Hydrogen gas flow to detector
3. 400 mL/min (60 psig) Air flow to detector
4. 225°C injector temperature
5. 250°C manifold temperature (detector)
6. 75°C column temperature

Note: The GC conditions have been chosen such that the analyte-related peaks elute as a cluster of unresolved peaks. Watch for distinctive patterns in searching for interferences and adjust GC conditions accordingly.

8.4.4 Injection. The first step in the analysis is the injection of the sample into the gas chromatograph. To eliminate difficulties arising from blow back or distillation within the syringe needle, one should employ the solvent flush

injection technique. The 10 microliter syringe is first flushed with solvent several times to wet the barrel and plunger. Three microliters of solvent are drawn into the syringe to increase the accuracy and reproducibility of the injected sample volume. The needle is removed from the solvent, and the plunger is pulled back about 0.2 microliter to separate the solvent flush from the sample with a pocket of air to be used as a marker. The needle is then immersed in the sample, and a 5 microliter aliquot is withdrawn, taking into consideration the volume of the needle, since the sample in the needle will be completely injected. After the needle is removed from the sample and prior to injection, the plunger is pulled back 1.2 microliters to minimize evaporation of the sample from the tip of the needle. Observe that the sample occupies 4.9-5.0 microliters in the barrel of the syringe. Duplicate injections of each sample and standard should be made. No more than a 3% difference in area is to be expected. An automatic sample injector can be used if it is shown to give reproducibility at least as good as the solvent flush technique.

8.4.5 Measurement of Area. The total area of the sample peaks is measured by an electronic integrator or some other suitable form of area measurement, and preliminary results are read from a standard curve prepared as discussed below.

8.5 Determination of Desorption Efficiency

8.5.1 Importance of Determination. The desorption efficiency of a particular compound can vary from one laboratory to another and also from one batch of charcoal to another. Thus, it is necessary to determine at least once the percentage of the specific compound that is removed in the desorption process, provided the same batch of charcoal is used.

8.5.2 Procedure for determining desorption efficiency. Activated charcoal equivalent to the amount in the first section of the sampling tube (100 mg) is measured into a 2.5 in, 4 mm I.D. glass tube, flame sealed at one end. This charcoal must be from the same batch as that used in obtaining the samples and can be obtained from unused charcoal tubes. The open end is capped with Parafilm. A known amount of the analyte is injected directly into the activated charcoal with a microliter syringe, and the tube is capped with more Parafilm. When using an automatic sample injector, the sample injector vials, capped with Teflon-faced septa, may be used in place of the glass tubes.

Six tubes at each of three concentration levels (0.5X, 1X and 2X of the standard) are prepared by adding an amount of analyte equivalent to that present in a 3 liter sample at the selected level. The tubes are allowed to stand for at least overnight to assure complete adsorption of the analyte

onto the charcoal. These tubes are referred to as the samples. A parallel blank tube should be treated in the same manner except that no sample is added to it. The sample and blank tubes are desorbed and analyzed in exactly the same manner as the sampling tube described in Section 8.4.

Two or three standards are prepared by injecting the same volume of compound into 1.0 mL of carbon disulfide with the same syringe used in the preparation of the samples. These are analyzed with the samples.

If the internal standard method is used, prepare calibration standards by using 1.0 mL of carbon disulfide containing a known amount of the internal standard.

The desorption efficiency (D.E.) equals the average weight in mg recovered from the tube divided by the weight in mg added to the tube, or

$$\text{D.E.} = \frac{\text{Average Weight (mg) recovered}}{\text{Weight (mg) added}}$$

The desorption efficiency is dependent on the amount of analyte collected on the charcoal. Plot the desorption efficiency versus weight of analyte found. This curve is used in Section 10.4 to correct for adsorption losses.

9. Calibration and Standards

Bulk samples of the analyte should be used for the calibration.

It is convenient to express concentration of standards in terms of mg per 1.0 mL carbon disulfide, because samples are desorbed in this amount of carbon disulfide. The density of the analyte is used to convert mg into microliters for easy measurement with a microliter syringe. A series of standards, varying in concentration over the range of interest, is prepared and analyzed under the same GC conditions and during the same time period as the unknown sample. Curves are established by plotting concentration in mg per 1.0 mL versus total area of relevant peaks.

For the internal standard method, use carbon disulfide containing a predetermined amount of the internal standard. The internal standard concentration used was approximately 70% of the concentration at 2X the standard. The analyte concentration in mg per mL is plotted versus the area ratio of the analyte peaks to that of the internal standard. Note: Whether the external standard or internal standard method is used, standard solutions should be analyzed at the same time the sample analysis is done. This will minimize the effect of variations in FID response.

10. Calculations

10.1 Read the weight, in mg, corresponding to each total peak area from the standard curve. No volume corrections are needed, because the standard curve is based on mg per 1.0 mL carbon disulfide and the volume of sample injected is identical to the volume of the standards injected.

10.2 Corrections for the blank must be made for each sample.

$$\text{mg} = \text{mg sample} - \text{mg blank}$$

where:

mg sample = mg found in front section of sample tube

mg blank = mg found in front section of blank tube

A similar procedure is followed for the backup sections.

10.3 Add the amounts present in the front and backup section of the same sample tube to determine the total weight in the sample.

10.4 Read the desorption efficiency from the curve (see Section 8.5.2) for the amount found in the front section. Divide the total weight by this desorption efficiency to obtain the corrected mg/sample.

$$\text{Corrected mg/sample} = \frac{\text{Total weight}}{\text{D.E.}}$$

10.5 The concentration of the analyte in the air sampled can be expressed in mg/m³.

$$\text{mg/m}^3 = \frac{\text{Corrected mg (Section 10.4)} \times 1000 \text{ (liters/m}^3\text{)}}{\text{Air Volume Sampled (liters)}}$$

10.6 Another method of expressing concentration is ppm (corrected to standard conditions of 25°C and 760 mm Hg).

$$\text{ppm} = \text{mg/m}^3 \times \frac{24.45}{\text{MW}} \times \frac{760}{P} \times \frac{(T + 273)}{298}$$

where:

- P = pressure (mm Hg) of air sampled
- T = temperature (°C) of air sampled
- 24.45 = molar volume (liter/mole) at 25°C and 760 mm Hg
- MW = molecular weight
- 760 = standard pressure (mm Hg)
- 298 = standard temperature (°K)

11. References

- 11.1 White, L.D. et al, "A Convenient Optimized Method for the Analysis of Selected Solvent Vapors in the Industrial Atmosphere," Amer. Ind. Hyg. Assoc. J., 31: 225 (1970).
- 11.2 Documentation of NIOSH Validation Tests, NIOSH Contract No. CDC-99-74-45.
- 11.3 Final Report, NIOSH Contract HSM-99-71-31, "Personal Sampler Pump for Charcoal Tubes," September 15, 1972. Sampling Equipment

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APPENDIX C
Sampling Equipment

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Sampling Pump

Manufacturer: E. I. Du Pont de Nemours & Co.
Wilmington DE 19898

Model: ALPHA 2

Description: Personal air-sampling instrument that moves a constant airflow through an external collection device. The automatic flow control system in the pump maintains the flow rate within $\pm 5\%$ over pressure drop changes up to 25 inches water.

Bubble Flow Meter

Manufacturer: Gillian Instrument Corp.
8 Dawes Highway
Wayne NJ 07470

Model: Buck Calibrator

Description: The calibrator measures the flow rate of gases over a fixed volume per unit of time. A microprocessor in conjunction with a quartz timer measures the time for a frictionless soap bubble to travel between two sensors (infrared) in the fixed volume flow tube. Flow results are displayed on a digital readout in cubic centimeters per minute (cc/min). The practical range of the instrument is 10 to 8000 cc/min. The flow meter provides an accuracy of $\pm 0.5\%$ with a repeatability of $\pm 0.5\%$ of any display. This unit is a primary standard with calibration traceable to National Bureau of Standards.

Sorbent Sample Tube

Manufacturer: SKC Inc.
334 Valley View Road
Eighty Four PA 15330-9614

Catalog No: 226-16

Description: Sorbent - charcoal (coconut base)

Tube size -outside diameter = 10 mm

Tube length = 110 mm

Sections - 2

Sorbent weight - front section = 800 mg

- back section = 200 mg

Lot No - 120

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APPENDIX D
Sampling Results and Calculations

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WHERE: Kelly AFB B/348 Texas

WHY: Volatile Organic Compound (VOC) Sampling for State Permitting Information

PRESURVEY DATE: 2 Dec 86

PRESURVEY TEAM: Major Garrison, Captain Fagin

PERSONNEL CONTACTED: 1) Calvin Bryant MATEC 925-4274
2) Bob Burns MATEC 925-4274
3) Hyland Lee MAQCE 925-3100
4) Lt Mike McGhee SGB 925-7544

ACTUAL SURVEY DATE: 19 Dec 86 (1st Day)

STACK FLOWRATE DETERMINATION

STACK IDENTIFICATION: EF-13

STACK STATIC PRESSURE: - 0.66 "H₂O

STACK INTERNAL DIAMETER: 24 inches

TRAVERSE POINTS: 16 Total, 8 per traverse

Point Distance (inches)

1	0.8
2	2.5
3	4.7
4	7.8
5	16.2
6	19.3
7	21.5
8	23.2

VELOCITY PRESSURE: (with 16 total points)

Point	Velocity Pressure ("H ₂ O)
-------	--

1A	.02
2A	.015
3A	.015
4A	.015
5A	.01
6A	.01
7A	.01
8A	.005

1B	.015
2B	.01
3B	.01
4B	.01
5B	.01
6B	.01
7B	.01
8B	.01

.01	Avg Vel Pres.
437	Avg Vel (FPM)
1,372	ACFM

=====

RUN 1 Stack: EF-13

PUMP	TIME ON	TIME OFF	PUMP CALIBRATION (CC/MIN)		% CHANGE
			PRE FLOW	POST FLOW	
2777	1155	1225	115	116	+ 0.87
2779	1155	1225	118	117	- 0.85
2795	1155	1225	128	127	- 0.78

TEST CONDITIONS: ONE TEST STAND IN OPERATION
TEST STAND -- F100 ENGINE FUEL NOZZLE (PWA 50010)

TEMPERATURE -- DRY BULB 76 DEGREES F
WET BULB 53 DEGREES F
AMBIENT 72 DEGREES F

BAROMETRIC PRESSURE -- 29.47 "Hg

RUN 2 Stack EF-13

PUMP	TIME ON	TIME OFF	PUMP CALIBRATION (CC/MIN)		% CHANGE
			PRE FLOW	POST FLOW	
2787	1245	1315	125	126	+ 0.80
2793	1245	1315	99	100	+ 1.01
2783	1245	1315	108	107	- 0.93

TEST CONDITIONS: ONE TEST STAND IN OPERATION
TEST STAND -- TF-39 NOZZLES

TEMPERATURE -- DRY BULB 76 DEGREES F
WET BULB 53 DEGREES F
AMBIENT 72 DEGREES F

BAROMETRIC PRESSURE -- 29.47 "Hg

RUN 3 Stack EF-13

PUMP	TIME ON	TIME OFF	PUMP CALIBRATION (CC/MIN)		% CHANGE
			PRE FLOW	POST FLOW	
2795	1330	1400	127	127	0.00
2779	1330	1400	117	117	0.00
2777	1330	1400	116	115	- 0.86

TEST CONDITIONS: TWO TEST STANDS IN OPERATION
TEST STAND -- TF-39

TEMPERATURE -- DRY BULB 76 DEGREES F
WET BULB 53 DEGREES F
AMBIENT 72 DEGREES F

BAROMETRIC PRESSURE -- 29.47 "Hg

=====

RUN 4 Stack EF-13

PUMP	TIME ON	TIME OFF	PUMP CALIBRATION (CC/MIN)		% CHANGE
			PRE FLOW	POST FLOW	
2787	1410	1440	126	125	- 0.79
2783	1410	1440	107	104	- 2.80
2793	1410	1440	100	104	+ 4.00

TEST CONDITIONS: TWO TEST STANDS IN OPERATION
TEST STAND -- F100 ENGINE FUEL NOZZLE (PWA 50010)

TEMPERATURE -- DRY BULB 76 DEGREES F
WET BULB 53 DEGREES F
AMBIENT 72 DEGREES F

BAROMETRIC PRESSURE -- 29.47 "Hg

=====

ACTUAL SURVEY DATE: 22 Dec 86 (2nd Day)

STACK FLOWRATE DETERMINATION

STACK IDENTIFICATION: EF-27

STACK INTERNAL DIAMETER: 37 inches

STATIC PRESSURE: - 2 inches

TRAVERSE POINTS: 16 Total, 8 per Traverse Point

Point	Distance (Inches)
1	1.2
2	3.9
3	7.2
4	12.0
5	25.0
6	29.8
7	33.1
8	35.8

VELOCITY PRESSURE RESULTS: (with 16 Total Points)

Point	Velocity Pressure ("H ₂ O)
1A	.13
2A	.12
3A	.10
4A	.09
5A	.09
6A	.11
7A	.12
8A	.12
1B	.13
2B	.12
3B	.10
4B	.09
5B	.09
6B	.11
7B	.12
8B	.12

.11 Avg Vel Pres
1,365 Avg Vel (FPM)
10,193 ACFM

RUN 5 Stack: EF-27

PUMP	TIME ON	TIME OFF	PUMP CALIBRATION (CC/MIN)		% CHANGE
			PRE FLOW	POST FLOW	
2779	1000	1030	113	115	+ 1.77
2795	1000	1030	125	123	- 1.60
2777	1000	1030	114	111	- 2.63

TEST CONDITIONS: ONE TEST STAND (OPEN BODY) IN OPERATION
TEST STAND -- F100 UFC (UNIFIED FUEL CONTROL)
PWA 50002-102 (PM 04472)

TEMPERATURE -- DRY BULB 76 DEGREES F
WET BULB 56 DEGREES F
AMBIENT 74 DEGREES F

BAROMETRIC PRESSURE -- 29.28 "Hg

RUN 6 Stack EF-27

PUMP	TIME ON	TIME OFF	PUMP CALIBRATION (CC/MIN)		% CHANGE
			PRE FLOW	POST FLOW	
2783	1145	1215	102	102	0.00
2793	1145	1215	100	100	0.00
2787	1145	1215	123	123	0.00

TEST CONDITIONS: ONE TEST STAND (CLOSED BODY) IN OPERATION
TEST STAND -- F100 UFC (UNIFIED FUEL CONTROL)
PWA 50002-102 (PM 04472)

TEMPERATURE -- DRY BULB 76 DEGREES F
WET BULB 56 DEGREES F
AMBIENT 74 DEGREES F

BAROMETRIC PRESSURE -- 29.28 "Hg

RUN 7 Stack EF-27

PUMP	TIME ON	TIME OFF	PUMP CALIBRATION (CC/MIN)		% CHANGE
			PRE FLOW	POST FLOW	
2795	1245	1315	123	123	0.00
2777	1245	1315	111	110	- 0.90
2779	1245	1315	115	112	- 2.61

TEST CONDITIONS: TWO TEST STANDS (CLOSED BODY) IN OPERATION
TEST STAND -- F100 UFC (UNIFIED FUEL CONTROL)
PWA 50002-102 (PM 04472 & PM 04468)

TEMPERATURE -- DRY BULB 76 DEGREES F
WET BULB 56 DEGREES F
AMBIENT 74 DEGREES F

BAROMETRIC PRESSURE -- 29.28 "Hg

RUN 8 Stack EF-27

PUMP	TIME ON	TIME OFF	PUMP CALIBRATION (CC/MIN)		% CHANGE
			PRE FLOW	POST FLOW	
2793	1330	1400	100	99	- 1.00
2783	1330	1400	102	103	+ 0.98
2787	1330	1400	123	121	- 1.63

TEST CONDITIONS: TWO TEST STANDS (OPEN BODY) IN OPERATION
TEST STAND -- F100 UFC (UNIFIED FUEL CONTROL)
PWA 50002-102 (PM 04472 & PM 04468)

TEMPERATURE -- DRY BULB 76 DEGREES F
WET BULB 56 DEGREES F
AMBIENT 74 DEGREES F

BAROMETRIC PRESSURE -- 29.28 "Hg

ACTUAL SURVEY DATE: 27 Feb 87 (3rd Day)

STACK FLOWRATE DETERMINATION

STACK IDENTIFICATION: EF-13

STACK STATIC PRESSURE: - 0.66 "H₂O

STACK INTERNAL DIAMETER: 24 inches

TRAVERSE POINTS: 16 Total, 8 per Traverse

Point	Distance (inches)
1	0.8
2	2.5
3	4.7
4	7.8
5	16.2
6	19.3
7	21.5
8	23.2

VELOCITY PRESSURE RESULTS: (with 16 Total Points)

Point	Velocity Pressure ("H ₂ O)
1A	.015
2A	.02
3A	.015
4A	.015
5A	.01
6A	.01
7A	.01
8A	.005
1B	.015
2B	.015
3B	.015
4B	.01
5B	.015
6B	.01
7B	.01
8B	.01

.01 Avg Vel Pres
 457 Avg Vel (FMP)
 1,437 ACFM

RUN 9 Stack: EF-13

PUMP	TIME ON	TIME OFF	PUMP CALIBRATION (CC/MIN)		% CHANGE
			PRE FLOW	POST FLOW	
2782	0900	0930	114	111	- 2.63
2786	0900	0930	105	101	- 3.81
2790	0900	0930	97	92	- 5.15

TEST CONDITIONS: ONE TEST STAND IN OPERATION
 TEST STAND -- TF-39 NOZZLES

TEMPERATURE -- DRY BULB 76 DEGREES F
 WET BULB 65 DEGREES F
 AMBIENT 72 DEGREES F

BAROMETRIC PRESSURE -- 29.03 "Hg

RUN 10 Stack EF-13

PUMP	TIME ON	TIME OFF	PUMP CALIBRATION (CC/MIN)		% CHANGE
			PRE FLOW	POST FLOW	
2780	1000	1030	96	94	- 2.08
2785	1000	1030	99	80	- 19.2
2791	1000	1030	107	230	+ 114.95

TEST CONDITIONS: ONE TEST STAND IN OPERATION
TEST STAND -- TF-39

TEMPERATURE -- DRY BULB 76 DEGREES F
 WET BULB 65 DEGREES F
 AMBIENT 72 DEGREES F

BAROMETRIC PRESSURE -- 29.03 "Hg

RUN 11 Stack: EF-13

PUMP	TIME ON	TIME OFF	PUMP CALIBRATION (CC/MIN)		% CHANGE
			PRE FLOW	POST FLOW	
2782	1230	1300	111	94	- 15.32
2786	1230	1300	101	82	- 18.81
2790	1230	1300	92	92	0.00

TEST CONDITIONS: TWO TEST STANDS IN OPERATION
TEST STAND -- TF-39 NOZZLES

TEMPERATURE -- DRY BULB 76 DEGREES F
 WET BULB 65 DEGREES F
 AMBIENT 72 DEGREES F

BAROMETRIC PRESSURE -- 29.03 "Hg

TABLE 1

	PUMP	BASE NUMBER	OEHL NUMBER	mg/m ³	ppm	AVG/RUN* mg/m ³
RUN 1	2777	PX860901	87577	389	67	385
	2779	PX860902	87578	376	65	
	2795	PX860903	87579	389	67	
	BLANK	PX860904	87580	N/D	N/D	
RUN 2	2787	PX860905	87581	314	54	329
	2793	PX860906	87582	336	58	
	2783	PX860907	87583	338	58	
	BLANK	PX860908	87584	N/D	N/D	
RUN 3	2795	PX860909	87585	284	49	279
	2779	PX860910	87586	269	46	
	2777	PX860911	87587	338	49	
	BLANK	PX860912	87588	N/D	N/D	
RUN 4	2787	PX860913	87589	692	119	747
	2783	PX860914	87590	765	132	
	2793	PX860915	87591	784	135	
	BLANK	PX860916	87592	N/D	N/D	
RUN 5	2779	PX860917	87593	276	48	279
	2795	PX860918	87594	245	43	
	2777	PX860919	87595	314	56	
	BLANK	PX860920	87596	N/D	N/D	
RUN 6	2783	PX860921	87597	265	46	216
	2793	PX860922	87598	214	37	
	2787	PX860923	87599	168	29	
	BLANK	PX860924	87600	N/D	N/D	
RUN 7	2795	PX860925	87601	209	36	215
	2777	PX860926	87602	205	36	
	2779	PX860927	87603	229	40	
	BLANK	PX860928	87604	N/D	N/D	
RUN 8	2793	PX860929	87605	458	80	459
	2783	PX860930	87606	482	84	
	2787	PX860931	87607	434	75	
	BLANK	PX860932	87608	N/D	N/D	

	PUMP	BASE NUMBER	OEHL NUMBER	mg/m ³	ppm	AVE/RUN* mg/m ³
RUN 9	2782	PX870933	12718	220	39	236
	2786	PX870934	12719	233	41	
	2790	PX870935	12720	253	44	
	BLANK	PX870936	12721	N/D	N/D	
RUN 10	2780	PX870941	12726	259	46	272
	2785	PX870942	12727	290	51	
	2791	PX870943	12728	266	47	
	BLANK	PX870944	12729	N/D	N/D	
RUN 11	2782	PX870937	12722	310	55	308
	2786	PX870938	12723	307	54	
	2790	PX870939	12724	304	54	
	BLANK	PX870940	12725	N/D	N/D	

* NOTE: All unified fuel control test stands have a cabinet and a sink exhaust. Most of the VOCs will be vented through the sink exhaust since this is the area where the calibration fluid flows openly. The cabinet exhaust vents the enclosed area behind the test stands. This area has small leaks and drips which occur at the connections of the lines for the calibration fluid. The actual percentage of total VOCs the sink exhaust vents versus the cabinet exhaust is unknown. However, we feel that the amount of VOCs vented through the cabinet exhaust is negligible. Therefore, we will assume that all VOCs are vented only through the sink exhaust.

AREA D	EF	FLOW RATE (cfm)**
	13	4480
	14	1600
	15	10650
	16	10650
	17	10650
	19	9360
	20	4710
	21	7100
	22	7100
AREA B	23	7700
	24	7700
	25	7100
	27	6718
	28	6718
	29	9858
	30	888
	31	1478
OTHER AREAS	18	4665
	26	400

** Original fan specifications - there may be degeneration in flow rates over time, original flow rates were used for worst case scenario

EMISSIONS FROM EF 13

Four Fuel Nozzle Test Stands

Test Stand	Machine ID No.	Test Mode		
		lb/hr Closed Body	lb/hr Open Body	lb/hr Fuel Nozzle
D2-4	50010-1	-----	-----	4.69
D2-5	50010-1	-----	-----	4.69
D2-6	TF-39	-----	-----	6.47
D2-7	TF-39	-----	-----	6.47

EMISSIONS FROM EF 14

Two Fuel Nozzle Test Stands

Three Unified Fuel Control (UFC) Test Stands

Test Stand	Machine ID No.	Test Mode		
		lb/hr Closed Body	lb/hr Open Body	lb/hr Fuel Nozzle
** 4	50010-3	-----	-----	6.47
5	50010-3	-----	-----	6.47
14	50006	~0.00	~0.00	-----
D3-4	50006	1.30	1.67	-----
D3-5	50006	1.30	1.67	-----

**Actual sampling of the T-56 Fuel Nozzle Test Stand was not accomplished. Therefore the worst case concentration will be assumed.

EMISSIONS FROM EF 19

Six UFC Test Stands

Test Stand	Machine ID No.	Test Mode		
		lb/hr Closed Body	lb/hr Open Body	lb/hr Fuel Nozzle
11	50173	~0.00	~0.00	-----
12	50173	~0.00	~0.00	-----
6	50173	~0.00	~0.00	-----
8	50173	~0.00	~0.00	-----
4	50173	7.58	9.80	-----
3	50173	7.58	9.80	-----

EMISSIONS FROM EF 20

Three UFC Test Stands

Test Stand	Machine ID No.	Test Mode		
		1b/hr Closed Body	1b/hr Open Body	1b/hr Fuel Nozzle
5	50175	3.82	4.93	-----
6	50175	3.82	4.93	-----
13	50173	0.00	0.00	-----

EMISSIONS FROM EF 23

Two UFC Test Stands

Test Stand	Machine ID No.	Test Mode		
		1b/hr Closed Body	1b/hr Open Body	1b/hr Fuel Nozzle
12	50002	6.24	8.06	-----
13	50002	6.24	8.06	-----

EMISSIONS FROM EF 24

Two UFC Test Stands

Test Stand	Machine ID No.	Test Mode		
		1b/hr Closed Body	1b/hr Open Body	1b/hr Fuel Nozzle
8	50002	6.24	8.06	-----
9	50002	6.24	8.06	-----

EMISSIONS FROM EF 27

Three UFC Test Stands

Test Stand	Machine ID No.	Test Mode		
		1b/hr Closed Body	1b/hr Open Body	1b/hr Fuel Nozzle
11	50002	5.44	7.03	-----
12	50002	5.44	7.03	-----
16	50002	5.44	7.03	-----

EMISSIONS FROM EF 28

Three UFC Test Stands

Test Stand	Machine ID No.	Test Mode		
		1b/hr Closed Body	1b/hr Open Body	1b/hr Fuel Nozzle
10	50002	5.44	7.03	-----
14	50002	5.44	7.03	-----
29	50002	5.44	7.03	-----

EMISSIONS FROM EF 29

Three UFC Test Stands

Test Stand	Machine ID No.	Test Mode		
		1b/hr Closed Body	1b/hr Open Body	1b/hr Fuel Nozzle
26	50002	7.99	10.32	-----
27	50002	7.99	10.32	-----
28	50002	7.99	10.32	-----

EMISSIONS FROM EF 30

Three UFC Test Stands

Test Stand	Machine ID No.	Test Mode		
		1b/hr Closed Body	1b/hr Open Body	1b/hr Fuel Nozzle
4	50004	0.72	0.93	-----
*** 5	50004	0.72	0.93	-----
*** 9	50004	0.72	0.93	-----

EMISSIONS FROM EF 31

Three UFC Test Stands

Test Stand	Machine ID No.	Test Mode		
		lb/hr Closed Body	lb/hr Open Body	lb/hr Fuel Nozzle
6	50004	1.20	1.55	-----
7	50004	1.20	1.55	-----
*** 8	50004	1.20	1.55	-----

NOTE: Exhaust fans 15, 16, 17, 18, 21, 22 and 25 have only cabinet exhaust being vented, see note above.

Table 2

TOTAL EMISSIONS (lb/hr)

EXHAUST FAN	FUEL NOZZLE	Unified Fuel Control		TOTAL
		CLOSED BODY	OPEN BODY	
13	22.32	-----	-----	22.32
14	12.94	2.60	3.34	18.88
19	-----	15.16	19.60	34.76
20	-----	7.64	9.86	17.50
23	-----	12.48	16.12	28.60
24	-----	12.48	16.12	28.60
27	-----	16.32	21.09	37.41
28	-----	16.32	21.09	37.41
29	-----	23.97	30.96	54.93
30	-----	2.16	2.79	4.95
31	-----	3.60	4.65	8.25
TOTAL	35.16	112.73	145.62	= 293.61

*** Designated as not running

NOTE: Exhaust fans 15, 16, 17, 18, 21, 22 and 25 have only cabinet exhaust being vented.

TABLE 3

PROJECTED WORST CASE SCENARIO / TEST STANDS RUNNING

EXHAUST FAN	TEST STAND ID No.	TOTAL LB/HR
13	D2-4, D2-6, D2-7	17.63
14	4, 5, D3-4, D3-5	16.28
15	17, 18	*
16	23, 24	*
17	21, 22	*
18	9, 10	*
19	6, 8, 3, 4	19.60
20	5, 13	4.93
21	30, 31	*
22	32	*
23	12, 13	16.12
24	8, 9	16.12
25	6	*
27	11, 15	14.06
28	10, 14	14.06
29	27	10.32
30	4	0.93
31	6, 7	3.10

		133.15

NOTE: It was estimated by Kelly personnel that approximately 2200 lb/hr of liquid Stoddard Solvent flows through each unified fuel control stand. Therefore with 38 stands running, there was approximately 83,600 lb/hr of Stoddard Solvent flowing. The 133.15 lb/hr represents only .16% of this total flow.

* See earlier explanation of exhaust fans 15,16,17,18,21,22 and 25 contribution to total VOCs.

APPENDIX E

Equations

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EQUATIONS:

$$\text{EQ. (1) } \text{mg/m}^3 = \frac{\frac{\text{mg sample} - \text{mg blank}}{\text{DE}} \times 1000 \text{ L/m}^3}{\text{Air Volume Sampled (L)}}$$

$$\text{EQ. (2) } \text{ppm} = \frac{\frac{\text{mg}}{\text{m}^3} \times \frac{24.45}{\text{MW}} \times \frac{760 \text{ mm Hg}}{P} \times \frac{T^\circ\text{C} + 273^\circ\text{K}}{298^\circ\text{K}}}$$

$$\text{EQ. (3) } \frac{\text{mg}}{\text{m}^3(\text{actual})} = \frac{\text{mg}}{\text{m}^3(\text{reported})} \times \frac{1}{\text{DE}}$$

$$\text{EQ. (4) } \text{lb/hr} = \frac{\text{mg}}{\text{m}^3} \times \frac{\text{ft}^3}{\text{min}} \times \frac{60 \text{ min}}{\text{hr}} \times \frac{\text{m}^3}{35.31 \text{ ft}^3} \times \frac{\text{lb}}{453,000 \text{ mg}}$$

mg = milligrams

m³ = cubic meters

L = liters

DE = desorption efficiency

MW = molecular weight (144 for stoddard solvent)

P = barometric pressure (mm Hg)

ppm = parts per million

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APPENDIX F

Example Calculations

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EXAMPLE CALCULATIONS:

The following example calculations used the data associated with sample No. PX860901 (OEHL No. 87577):

mg/m ³ (reported)	=	0.292
mg/m ³ (average)	=	0.385
mg sample	=	1.012
DE	=	75%
Air Volume Sampled (L)	=	3.47
MW	=	144
P (inches water)	=	29.47
T (°C)	=	24.5
ft ³ /min (CFM)	=	4480

$$\text{EQ. (1)} \quad \text{mg/m}^3 = \frac{\frac{\text{mg sample} - \text{mg blank} \times 1000 \text{ L/m}^3}{\text{DE}}}{\text{Air Volume Sampled (L)}}$$

$$0.389 \text{ mg/m}^3 = \frac{\frac{1.012 \text{ mg} - 0.000 \text{ mg}}{0.75} \times 1000 \text{ L/m}^3}{3.47 \text{ L}}$$

$$\text{EQ. (2)} \quad \text{ppm} = \frac{\text{mg}}{\text{m}^3} \times \frac{24.45}{\text{MW}} \times \frac{760 \text{ mm Hg}}{P} \times \frac{T^\circ\text{C} + 273^\circ\text{K}}{298^\circ\text{K}}$$

$$.067 \text{ ppm} = \frac{.389 \text{ mg}}{\text{m}^3} \times \frac{24.45}{144} \times \frac{760 \text{ mm Hg}}{748.5 \text{ mm Hg}} \times \frac{24.5^\circ\text{C} + 273^\circ\text{K}}{298^\circ\text{K}}$$

$$\text{EQ. (3)} \quad \frac{\text{mg}}{\text{m}^3} (\text{actual}) = \frac{\text{mg}}{\text{m}^3} (\text{reported}) \times \frac{1}{\text{DE}}$$

$$\frac{.389 \text{ mg}}{\text{m}^3} (\text{actual}) = \frac{.292 \text{ mg}}{\text{m}^3} (\text{reported}) \times \frac{1}{0.75}$$

$$\text{EQ. (4)} \quad \text{lb/hr} = \frac{\text{mg}}{\text{m}^3} \times \frac{\text{ft}^3}{\text{min}} \times \frac{60 \text{ min}}{\text{hr}} \times \frac{\text{m}^3}{35.31 \text{ ft}^3} \times \frac{\text{lb}}{453,000 \text{ mg}}$$

$$0.0065 \text{ lb/hr} = \frac{.385 \text{ mg}}{\text{m}^3} \times \frac{4480 \text{ ft}^3}{\text{min}} \times \frac{60 \text{ min}}{\text{hr}} \times \frac{\text{m}^3}{35.31 \text{ ft}^3} \times \frac{\text{lb}}{453,000 \text{ mg}}$$

APPENDIX G
Field and Laboratory Data

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The following information is presented in this appendix:

1. Field data - Data collected during sampling of the carbon adsorption system. Provides operational parameters for the adsorption system as well as sampling pumps during testing.
2. Laboratory/chemist identification.
3. Industrial Hygiene Sampling Data Form - Data forms submitted to our laboratory requesting charcoal tube analysis for Stoddard Solvent.
4. Laboratory Analysis Report and Record Form - Results from laboratory analysis of charcoal tubes showing total amount of Stoddard Solvent collected on front and back sections of each tube. Each tube is identified by the USAFOEHL number supplied on the Industrial Hygiene Sampling Data Sheet.
5. Results of desorption efficiency for Stoddard Solvent - Six spiked charcoal samples with known amount of sample were submitted to chemist for analysis. Amount of sample in each tube was not known by person doing efficiency study. Results of analysis were compared to the amount initially added to obtain desorption efficiency. Since the desorption efficiencies were fairly close for four of the six samples (two results considered outlying values) over the range of samples, it was decided to average these values to determine one overall desorption efficiency.

LABORATORY ANALYSIS REPORT AND RECORD (General)				DATE ⁰⁷ JAN 1987	
TO:			FROM:		
SAMPLE IDENTITY				DATE RECEIVED	
				29 Dec 86	
SAMPLE FROM				LAB CONTROL NO	
BLDG 348				87577 - 608	
TEST FOR					
STODDARD SOLVENT					
RESULTS					
OEHL *	BASE *	mg FRONT SECTION	mg BACK SECTION	TOTAL mg/m ³	
87577	PX860901	1.012	ND	292	
87578	PX860902	0.994	ND	282	
87579	PX860903	1.120	ND	292	
87580	PX860904	ND	ND	—	
87581	PX860905	0.865	ND	236	
87582	PX860906	0.756	ND	252	
87583	PX860907	0.822	ND	254	
87584	PX860908	ND	ND	—	
87585	PX860909	0.808	ND	213	
87586	PX860910	0.712	ND	202	

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 LIAISON / EQC

 CAPT FASIN

LABORATORY ANALYSIS REPORT AND RECORD (General)				DATE	
TO:			FROM:		
SAMPLE IDENTITY				DATE RECEIVED	
SAMPLE FROM				LAB CONTROL NR	
TEST FOR					
RESULTS					
DEHL*	BASE*	mg FRONT SECTION	mg BACK SECTION	TOTAL mg/m ³	
87587	PX860911	0.738	ND	213	
87588	PX860912	ND	ND	—	
87589	PX860913	1.456	ND	519	
87590	PX860914	1.820	ND	574	
87591	PX860915	1.798	ND	588	
87592	PX860916	ND	ND	—	
87593	PX860917	0.705	ND	207	
87594	PX860918	0.684	ND	184	
87595	PX860919	0.796	ND	236	
87596	PX860920	ND	ND	—	
87597	PX860921	0.608	ND	199	
REQUESTING AGENCY (Mailing Address) <div style="text-align: center;">C-62</div>					

LABORATORY ANALYSIS REPORT AND RECORD (General)				DATE	
TO:			FROM:		
SAMPLE IDENTITY				DATE RECEIVED	
SAMPLE FROM				LAB CONTROL NN	
TEST FOR					
RESULTS					
OEHL #	BASE #	mg FRONT SECTION	mg BACK SECTION	TOTAL mg/m ³	
87598	PX860922	0.484	ND	161	
87599	PX860923	0.466	ND	126	
87600	PX860924	ND	ND	—	
87601	PX860925	0.580	ND	157	
87602	PX860926	0.512	ND	154	
87603	PX860927	0.586	ND	172	
87604	PX860928	ND	ND	—	
87605	PX860929	1.028	ND	344	
87606	PX860930	1.116	ND	362	
87607	PX860931	1.194	ND	326	
87608	PX860932	ND	ND	—	
REQUESTING AGENCY (Mailing Address) <div style="text-align: right;">(OVER)</div>					

LABORATORY ANALYSIS REPORT AND RECORD (General)		DATE
TO:	FROM:	
SAMPLE IDENTITY	DATE RECEIVED	
SAMPLE FROM	LAB CONTROL NR	
TEST FOR		

ND - NONE DETECTED

PLEASE NOTE (1) RESULTS ARE CALCULATED FROM SAMPLE VOLUMES INDICATED ON
AT FROM 2750.

(2) DESCRIPTION STUDY SHOWS THAT A RECOVERY RATE OF 75%
WAS OBTAINED

(3) RESULTS NOT CORRECTED FOR DESCRIPTION EFFICIENCY VALUE

Andrew Richardson, III
ANDREW RICHARDSON, III, GS-12
Chief, IH Analysis Section

REQUESTING AGENCY Mailing Address:

LABORATORY ANALYSIS REPORT AND RECORD (General)

DATE 23 MAR 1987

TO:

FROM:

SAMPLE IDENTITY

DATE RECEIVED

5 MARCH 87

SAMPLE FROM

BLDG 348

LAB CONTROL NR

12718 - 729

TEST FOR

STANDARD SOLVENT

RESULTS

	OEHL#	BASE #	mg FRONT SECTION	mg BACK SECTION	TOTAL mg/m ²
2	12718	PX870933	0.619	ND	183
2	12719	PX870934	0.601	ND	194
2	12720	PX870935	0.595	ND	210
2	12721	PX870936	ND	ND	—
2	12722	PX870937	0.796	ND	258
2	12723	PX870938	0.700	ND	255
2	12724	PX870939	0.697	ND	253
2	12725	PX870940	ND	ND	—
2	12726	PX870941	0.613	ND	215
2	12727	PX870942	0.650	ND	241
2	12728	PX870943	1.120	ND	221
2	12729	PX870944	ND	ND	—

ND = NONE DETECTED

DESORPTION EFFICIENCY = 83 %

REQUESTING AGENCY (Mailing Address)

EC/G

ATT. CAPT FAGIN

Andrew Richardson, III

ANDREW RICHARDSON, III, GS-12
FBI, Laboratory Division

GLOSSARY

DE	- Desorption efficiency
T	- Temperature of air sampled (°C)
24.45	- Molar volume at 25°C and 760 mm Hg (L/mole)
MW	- Molecular weight of Stoddard Solvent (144)
760	- Standard pressure (mm Hg)
298	- Standard temperature (°K)
P	- Pressure of gas sampled - atmospheric + duct static pressures (mm Hg)
mg	- milligrams
ppm	- parts per million
mm	- millimeters
m ³	- cubic meters
cc	- cubic centimeters
L	- liters
ft ³	- cubic feet
ACFM	- actual cubic feet per minute
CFM	- cubic feet per minute
min	- minute
hr	- hour
gr	- gram
F	- degrees Fahrenheit
C	- degrees Celsius
K	- degrees Kelvin

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END

DATE

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